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JAPAN'S PROGRESS IN ALTERNATIVE ENERGY DEVELOPMENT

Summary

A recovering economy led to increased Japanese crude oil imports in FY 1983, reversing one of the major trends outlined in JEI's last energy report (see JEI Report No. 14A, April 15, 1983). The growth of alternative energy supplies and other major trends remained the same, however. The success of conservation and readjustment measures and lower growth prospects encouraged the Ministry of International Trade and Industry to revise downward its long-term energy demand and supply forecast again in 1983.

Lower oil prices contributed to the economy's positive price and production performances, but the drive to develop non-oil energy sources did not abate. U.S.-Japan energy cooperation also continued to broaden, and the year proved to be mostly friction-free in this area.

1983 Consumption

In calendar year 1983, Japan imported 1.3 billion barrels of crude oil -- 3.2 percent less than in 1982 and the fifth consecutive annual decline in imports (see Table 1). Imports accounted for 99.8 percent of crude oil supplies as domestic production crept back up to 3.1 million barrels. The refinery operation rate also showed marginal improvement, rising from 56.5 percent to 56.9 percent, and reaching as high as 74.6 percent during the year. The price of imported crude (c.i.f.) underwent a sharp decline from 1982's $34.66 per barrel, averaging $30.77 a barrel in 1983 but hitting $29.56 by

year's end (see Table 2). Lackluster economic activity took the edge off of an unusually cold winter, and wholesale and consumer prices for petroleum products eased (see Table 3).

Imports of other energy sources painted a varied picture. Coal imports fell to 75.1 million metric tons, primarily because of an 8.2 percent drop in coking coal. Imports of naphtha rebounded strongly (rising 45.5 percent) as domestic refiners cut back their output by 16.6 percent despite an overall sales increase of 4.9 percent. Liquefied natural gas (LNG) imports rose 7.3 percent, while imports of liquefied petroleum gas (LPG) dropped 8.5 percent (see Table 4).

The pattern of industrial consumption continued to shift: consumption of heavy fuel oil by the manufacturing sector fell 8.1 percent in 1983; light oil use rose 6.5 percent; and coal and electricity demand dropped, primarily because of stagnant steel and construction activity, although improved efficiency also pushed these figures down (see Table 5).

Electric utilities continued to up their output while shifting from oil to coal and alternative supplies for inputs (see Table 6). There was a significant jump in the amount of hydroelectric power generated, while power from nuclear and thermal (fossil fuel and geothermal) plants showed minimal increases.

Household consumption (Table 7) also began to move away from solid fossil fuels in favor of electricity (up 7.1 percent in 1983), LPG (increasing 3.1 percent) and propane (a 4.4 percent gain).

New Long-Term Energy Outlook

In August 1983, an advisory panel to the Ministry of International Trade and Industry (MITI) revised its 1982 estimates of long-term energy demand in response to the changing energy efficiency of the economy and slower economic growth. The most recent projection is summarized in Table 8, along with actual consumption figures for fiscal year 1982 (April 1, 1982-March 30, 1983). The revised figures are significantly lower than the 1982 forecast: the projection for FY 1990 has been scaled back by 22 percent and the FY 2000 figure by 22.1 percent.

By categories, the new FY 1990 estimates show declines in coal of 29.4 percent; nuclear power, 26.1 percent; natural gas, 17.6 percent; hydroelectric power, 12.1 percent; geothermal power, 75 percent; alternative energy sources, 46.7 percent; and petroleum, 17.2 percent. A comparison of the revised and 1982 outlooks for FY 2000 demand reveal equally big reductions, with coal usage off 20 percent; nuclear energy, 31.1 percent; natural gas, 20.7 percent; hydroelectric power, 22.2 percent; geothermal supplies, 56.7 percent; other alternative energy sources, 30.8 percent; and petroleum, 12.1 percent.

The thrust of the new forecast is a slower shift from petroleum and a sharply reduced role for non-fossil fuel energy sources. Petroleum's share of total energy supplies is now pegged at 52.5 percent in FY 1990 and 42 percent

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in FY 2000, up slightly from 1982's projected rates of 49.1 percent and 38 percent, respectively. The use of coal has also been revised upward. Nuclear, geothermal, hydroelectric and alternative sources of power have been downgraded for a variety of reasons: increasing local opposition to new nuclear power plants; fewer suitable hydroelectric sites; and the decreasing cost competitiveness of alternatives such as LNG and synthetic fuels, among others. Despite scaled-back expectations, the drive to bring online new sources of energy and improve conservation measures continues.

Government Policy on Energy

A three-pronged strategy is presently being pursued by the government to strengthen Japan's energy security. While taking into account cost and other factors, the basic outline of the plan includes:

- A secure and stable supply of oil.

  Strengthened relations with oil-producing countries.
  Resource development by Japanese companies.
  Promotion of oil stockpiling.
  Structural reform of industry.

- Promotion of the development and use of alternative energies -- nuclear power, coal, LNG and new energy sources.

- Energy conservation.

  Public information activities and campaigns aimed at the industrial, commercial, residential and transportation sectors.
  Investment in energy-saving equipment.
  Development of energy conservation technology.

The first prong of the plan contains two interesting points -- strengthening relations with oil-producing countries and promoting structural reform of industry. The commitment to maintaining good relations with oil suppliers has put Japan in an awkward position at times. Most recently, the Iran-Iraq war has jeopardized the country's energy security. Japan gets nearly three-quarters of its oil from Persian Gulf states. Although Tokyo has stressed its neutral stance with both countries and has embarked on a campaign to end the conflict, neither effort has had much effect on the war. The unusually intense diplomatic activity, however, underlines Tokyo's commitment to this policy (see JEI Report No. 22B, June 8, 1984).

Equally daunting is the task of restructuring domestic industry to meet the new conditions of reduced growth and lower oil prices. In February 1984, the Japanese Petroleum Council submitted to MITI a plan to enhance the competitiveness of the large oil companies by forcing a reduction of refining capacity and a regrouping of market shares. The plan calls for a reduction in the number of oil companies to six or seven (there are at present 13), with one or perhaps two firms holding a 25 percent market share and the remaining companies about 10 percent each. To accomplish this, the plans call for preferential distribution quotas and subsidized loans for new refinery construction. Smaller firms will undoubtedly come under pressure to merge with

larger ones in an attempt to end the fierce price wars that have pushed eight petroleum corporations into the red over the last six months. While MITI insists that the plan to reduce "excess competition" is completely voluntary, the oil refiners insist that there is nothing voluntary about it.

Tokyo has largely accomplished its other energy security goals. Current petroleum reserves are equivalent to 120 days of consumption and reserves of LNG are being built up from 25 to 45 days. Japanese energy companies remain active in exploration in many areas of the world, including China, Canada and Australia.

Alternative Energy Development

Japan's alternative energy program, the second prong of the government's plan, is beginning to yield commercial applications. The major emphasis remains on nuclear power development and coal conversion projects, although strides are also being made in increasing the use of geothermal and solar power. Most interesting, however, are recent developments in exotic energy technologies, including biotechnologic sources, wind power and hydrogen power.

Nuclear Power -- Commercialization is underway in three areas: construction of an advanced thermal reactor (ATR); operation of an uranium enrichment plant using domestic technology; and construction of a nuclear fuel recycling plant. Based upon the "Fugen" prototype ATR in operation since 1979, a demonstration reactor is slated for construction in the late 1980s. Geological and environmental surveys are now in progress for the reactor, which will use heavy-water modulation and pressurized light-water boiling/cooling technology. This variety of reactor should yield improved fuel efficiency and easier maintenance.

An uranium enrichment pilot plant using the centrifuge separation technique has been in operation since 1979. The government-funded Power Reactor and Nuclear Fuel Development Corp. is now working with the private sector to construct a full-scale commercial plant that will go into operation within the next few years. The field should develop rapidly thanks to a U.S.-Japan agreement to allow private Japanese companies to build enrichment plants whose output would be mixed with U.S.-supplied enriched fuel. This unusual exception to U.S. nuclear non-proliferation laws, which was announced last January, will allow enriched uranium used in Japanese power plants to contain up to 30 percent domestically produced fuel, in contrast to previous rules barring any combinations of American and foreign products.

The Japan Atomic Energy Service Co., Ltd. is planning to open a second fuel reprocessing plant in 1985 to augment the Tokai reprocessing plant that experienced a breakdown in February of last year. The Federation of Electric Power Companies has also announced that it will construct a reprocessing facility on the Shimokita peninsula in Aomori Prefecture. This month, an advisory panel called for construction of reprocessing capacity equal to one-half of Japan's spent fuel output (800 tons) by the year 2000 to reduce its dependence on the United States. The reprocessing issue has caused some problems between the United States and Japan, primarily because of strict U.S. laws. While progress has been slow, negotiations are continuing.

Research and development efforts for a fast-breeder reactor took an interesting twist when Washington plumbed Tokyo's interest in purchasing parts of the defunct Clinch River fast-breeder reactor project. Despite obvious interest, the Japanese stressed that many technical factors had to be discussed before any decision could be reached. In the meantime, construction of the prototype "Monju" fast breeder is continuing.

Progress toward nuclear fusion took an important step forward this month when the Japan Atomic Energy Research Institute successfully generated a powerful magnetic field using superconductive elements. The field strength of 11 teslas (1 tesla is approximately equal to 27,000 times the strength of the earth's magnetic field) approaches the institute's 12 tesla goal, which is envisioned as sufficient for use in a commercial power plant. Installation of a magnetic toroid-type (Tokamak) reactor is moving toward its 1986 completion date without major problems.

Technology is not the major obstacle hindering increased use of nuclear power, however. Political problems pose a much larger hurdle. Concern over safety is still strong, and the growing problem of waste storage is prompting public reconsideration of ambitious government plans. The magnitude of those ambitions was made clear in the new ten-year power development plan announced July 5, 1984. In it, the number of nuclear plants is expected to double to 52 by the end of FY 1993 and nuclear power as a share of total generating capacity is forecast to rise from the current 20 percent to 33 percent or 44.73 million kilowatts. Winning public support for the large increase will be contingent on the government's success at solving the nuclear waste disposal question. A plan to bury low-level radioactive waste in ocean seabeds is Tokyo's present idea, but it requires approval from Japan's neighbors.

Coal -- Coal will play an increasingly important role in Japan's energy mix, both as a solid fuel (its share of total generating capacity will rise from the current 8 percent to 12 percent by 1993) and as a liquid or gaseous fuel. On July 2, 1984, nearly two dozen private firms, including Nippon Steel Corp., Hitachi, Ltd., and Mitsubishi Heavy Industries, Ltd., announced that they will form a joint venture in September to construct a pilot coal liquefaction plant using the U.S.-developed solvent refined coal (SRC) process. The Y118 billion ($502 million) project, which will receive Y100 billion in government funds, will be capable of converting 250 tons of coal a day into liquid fuel by 1990 and its success will determine the fate of larger projects. A second liquefaction experiment is being conducted in cooperation with Australia. The tiny pilot plant will go onstream next March and will convert into heating fuel 50 tons a day of inexpensive brown coal. If high-sulphur-content problems can be overcome, the technology could well contribute to the country's energy security.

Gasification pilot plants are also in operation. Under MITI's Sunshine Project, the problems associated with processing different types of coal are being explored at a high-caloric gas plant with a capacity of 7,000 cubic meters a day and a low-caloric gas plant. A steam/gas generating turbine system is being developed to run on the low-caloric gas. Under present price estimates for petroleum, these liquid and gaseous alternatives will become competitive by the end of the century.

Solar Energy -- Commercialization of solar energy technologies is one of the main thrusts of the Sunshine Project. Attention is being devoted to mass production of photovoltaic units by the 1990s. Technologies based on crystalline silicon are relatively well developed and are employed on a small scale by an increasing number of businesses as well as homes. Projects aimed at lowering the cost of producing the silicon substrate and improving the conversion efficiency of the cells (to perhaps as high as 20 percent) are the major goals at present. The development of commercially applicable amorphous silicon (a-Si) technologies is receiving the greatest attention at present.

Amorphous silicon solar cells have several advantages -- lower cost, larger cell sizes, less silicon, and simpler production -- over crystalline cells. But they also have major drawbacks -- lower conversion efficiency, a shorter useful life, and lower reliability. The Sunshine Project is providing some funds to develop a-Si manufacturing techniques at a number of Japanese companies. Kyocera Corp. has developed an a-Si cell with an inexpensive ceramic substrate that offers improved durability and lower cost and has demonstrated efficiencies as high as 7.1 percent for a 1 square meter cell. Sumitomo Electric Industries, Ltd. is developing multiple layer a-Si cells that promise to match current crystalline cell efficiencies (14-15 percent). Sanyo Electric Co., Ltd. is focusing on advanced a-Si production techniques which could yield a one-step continuous casting process. Mitsubishi Electric Corp. is developing large cell modules with a ten-year life span and an average 85 percent reliability. Finally, Fuji Electric Co., Ltd. is trying to develop manufacturing techniques for extremely large (12 square meters) a-Si cells.

Research on wet solar cells (utilizing an aqueous electrolyte) and heterostructural cells is being promoted, as are studies of new cell materials (gallium-arsenide, timonium, indium, cadmium and zinc), improved durability, and reliability. Pilot plants that rely on solar thermal power generation round out the development of solar energy.

Geothermal Energy -- Current generating capacity from geothermal sources stands at 215.1 megawatts distributed among nine plants, just three of which have a capacity of 50 megawatts or more. Geothermal output should rise by nearly a factor of ten by 2000 and its share of the total energy supply should jump from 0.1 percent to 1 percent. While the basic technology is well-proven, problems of site accessibility hamper more rapid development. It is possible that this obstacle could abate if the government's plan to distribute new industries geographically leads to increased demand closer to geothermal sites.

In the meantime, development is proceeding on the utilization of hot water generated in the production process as well as on drilling technologies. Hot-water heating of greenhouses and buildings is one possibility. More interesting is the development of "binary technology," which would use the hot water to produce high pressure vapor to power turbines. When freon or isobutane is mixed with the hot effluent, it vaporizes energetically to drive a generator. The process could improve the competitiveness of this already cost effective alternative.

Exotic Sources -- Under this rubric the government encourages development of marginal energy sources such as wind power or infant technologies like artificial photosynthesis. Monetary support for these

projects is usually small, but enough to help a company develop viable technology or build a basic research foundation.

Wind power equipment will be sold for the first time by a Japanese company this year if Toyo Menka Kaisha, Ltd. and Mitsui Engineering and Shipbuilding Co., Ltd. can find customers. The two firms have developed a system capable of generating 10 to 50 kilowatts of electricity with wind speeds as low as 2 to 3 meters per second (4 to 6 miles per hour). While the system will be offered to customers in Japan, it is primarily intended for application in remote areas of third world countries.

Ocean thermal energy conversion holds great potential for the island nation, and the Japanese are watching closely a Department of Energy pilot facility in Hawaii. This process uses the temperature differential between surface and deep ocean water to drive low-pressure turbines.

Creative biotechnology applications could produce significant new sources of energy. Biomass and gasahol projects have been in progress for several years, and commercialization is anticipated before the end of the century. Artificial photosynthesis promises to reduce the limitations presented by a finite supply of fossil fuels through direct production of raw fuel stocks. Its emergence could also enhance the efficiency of solar cells and lead to an economic method of extracting hydrogen fuel directly from water.

Hydrogen fuel technology is advancing rapidly. A demonstration hydrogen-fueled automobile has been tested, and a number of private companies are working on hydrogen fuel cell technology. The Hydrogen Energy Development Research Institute has already established service facilities in Japan to retool conventional automobile engines to run on hydrogen and has even formed a U.S. subsidiary to market its products here.

While the payoff from these programs may be small or distant, the government remains committed to diversifying and improving the country's energy mix. Planners are convinced that the combined effect of all these programs will greatly reduce Japan's dependence on foreign energy sources.

Conservation Efforts -- Conservation programs are in effect in almost all major firms, though the largest gains in savings are due to the shift away from energy-intensive manufactures. The government is in the process of developing a long-term plan to encourage energy conservation by consumers and producers.

Public Funding

Financial support from the government remains solid in an era of fiscal restraint -- the energy budget rose 0.9 percent for FY 1984 despite an overall budget increase of only 0.5 percent. The general account budget contains over Y156 million ($678,000) for nuclear energy development by the Science and Technology Agency; over Y5 million ($22,000) for MITI's energy technology R&D; Y3 million ($13,000) for MITI's Energy Resource Agency; Y440 million ($1.9 million) for work on crude oil substitutes; and Y5.7 million ($24,000) for geothermal development. Including energy expenditures by other government agencies, total outlays for energy countermeasures are expected to reach Y603.2

billion ($2.6 billion) during the current fiscal year, primarily for oil stockpiling costs and industry restructuring.

A large portion of this money is transferred to a special account for coal, oil and alternative energy development, which also receives nearly all of the revenues from various oil taxes. The special account for promotion of electric power generation funds the development of nuclear power and the oil-to-coal conversion projects, drawing its resources from utility taxes. Both accounts in FY 1984 reflect the effects of the recession and lower oil prices.

The budget of the New Energy Development Organization (NEDO) -- a semi-governmental agency set up in 1980 to promote research and development and the commercialization of alternative and renewable energy technologies -- increased 11.1 percent in FY 1983 (see Table 9). Its industry-related programs expanded to Y210 billion ($894 million), of which Y38 billion ($163 million) was devoted to new energy technologies and Y52 billion ($222 million) each to coal development and geothermal projects. Another Y91 billion ($389 million) was absorbed by coal industry restructuring and Y18 billion ($76 million) went to alcohol-fuel related projects. It is significant that even during a recession year, NEDO increased its energy development outlays in every case except coal development.

U.S.-Japan Energy Cooperation

Japan's dependence on imported petroleum and the escalation of the Iran-Iraq war in recent months has prompted Tokyo to meet with the United States to discuss oil-sharing contingency plans. The response to the Persian Gulf war has been quite rational, unlike earlier oil crises. Previous experience undoubtedly drove home the importance of cooperation among the industrialized countries. The oil glut and adequate emergency reserves have held down panic buying. It is clear that Japan and the United States will face any future oil squeeze with a stronger, more cohesive relationship.

Bilateral cooperation in the development of new energy technologies has also improved over the past year, with joint research programs in fusion energy as well as an engineer exchange program with the Tennessee Valley Authority (TVA). This program is an improvement of a 1982 technical cooperation agreement. Cooperation in the geothermal field is also in place, and a experimental station supported by the United States, Japan and West Germany has proved useful.

Stresses in the relationship do remain, however. The Export Administration Act still bars the export of Alaskan crude oil to Japan, and attempts by Alaska's congressional representatives to eliminate the restrictions have failed. Coal talks also proved to be a rough spot, even though President Reagan and Prime Minister Nakasone tried to smooth out the difficulties during the president's November 1983 trip to Japan. Japan's major coal buyers recently took the unusual step of coming to the the United States to meet with their American suppliers in an effort to improve relations, but the issue has become increasingly polarized in American circles. With demand slack and non-U.S. supplies abundant, the Japanese are naturally reluctant to increase their contracts for costly American coal. Americans, on the other

hand, see the huge bilateral trade imbalance and are demanding that Japan buy more coal to help correct it.

Conclusion

The Japanese energy sector is in the midst of drastic changes and readjustments forced on it by design and by shifting economic factors. The country's basic energy vulnerability will continue for decades, though with decreasing severity as non-oil supplies grow. In its campaign to diversify and stabilize its energy supplies, Japan is likely to leave no stone unturned. Cooperation with other countries, including the United States, will play an important role in developing new energy technologies as well as coping with any shocks to world energy supplies. The country is now beginning to reap the benefits of positive adjustment programs and their pace will only accelerate in the coming years. Japan has set ambitious domestic and foreign energy goals and seems well on the way to achieving them.

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The views expressed in this report are those of the author and do not necessarily represent those of the Japan Economic Institute.

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Table 1: Japan's Crude Oil Imports, Production and Inventories

(in thousands of barrels)

	Production	Imports	Throughout	Rate of Operation	Inventories
1979	3,560	1,764,247	1,584,181	73.1%	216,516
1980	3,177	1,615,480	1,462,123	67.3	238,020
1981	2,868	1,448,203	1,321,353	60.9	226,302
1982	2,937	1,350,369	1,225,566	56.5	205,916
1983	3,095	1,307,024	1,183,136	56.9	185,756
January	296	111,742	113,094	61.4	189,184
February	270	101,313	100,049	60.2	177,202
March	289	126,096	101,759	55.3	190,914
April	239	97,709	104,622	58.7	176,806
May	233	93,193	91,989	50.0	170,012
June	239	97,187	77,731	43.6	179,668
July	226	96,055	94,269	51.2	171,478
August	236	106,178	93,863	51.0	168,566
September	252	96,243	86,915	48.8	167,012
October	262	120,334	101,483	65.8	172,510
November	264	120,328	102,357	68.6	175,988
December	289	140,644	115,000	74.6	185,756
1984					
January	264	114,057	114,887	74.3	174,523
February	n.a.	122,712	118,277	82.0	158,609

Source: Petroleum Association of Japan

Table 2: Price (c.i.f.) of Imported Crude Oil

	Volume (1,000 bbl)	Value ($millions)	Dollars per bbl	Yen per kiloliter
1979	1,768,767	$33,471	$18.93	Y26,236
1980	1,600,352	52,749	32.97	47,197
1981	1,430,623	53,343	37.29	51,387
1982	1,334,958	46,266	34.66	53,906
1983	1,302,055	40,063	30.77	45,923
January	123,152	4,148	33.94	49,717
February	103,842	3,531	33.96	50,632
March	113,843	3,791	33.30	49,427
April	108,131	3,346	30.94	46,437
May	92,230	2,720	29.50	43,679
June	100,112	2,940	29.37	44,052
July	93,230	2,751	29.50	44,524
August	92,425	2,723	29.46	44,971
September	107,691	3,187	29.60	45,572
October	103,672	3,072	29.64	44,021
November	118,579	3,536	29.82	43,934
December	144,985	4,286	29.56	43,664
1984				
January	111,344	3,283	29.48	43,375
February	118,982	3,518	29.57	43,533
March	137,423	4,053	29.49	42,454
April	109,098	3,191	29.25	41,425

Source: Ministry of Finance

Table 3: Wholesale and Consumer Price Indices for Petroleum Products (1980 = 100)

	Wholesale Index			Consumer Index		Retail Prices	
	Gasoline	Naphtha	Fuel Oil*	Gasoline	Propane	Gasoline**	Propane***
1979	76.5	57.2	49.5	80.1	75.0	Y124.9	Y3,585
1980	100.0	100.0	100.0	100.0	100.0	154.8	4,881
1981	106.2	99.7	118.0	102.6	103.7	157.1	5,079
1982	114.1	101.4	124.1	111.8	103.9	172.0	5,104
1983	111.1	123.1	116.3	103.2	104.6	156.0	5,134
January	117.5	104.1	126.2	113.9	104.0	176	5,128
February	117.5	104.3	126.2	111.4	104.0	172	5,128
March	117.5	104.3	126.2	108.7	104.0	168	5,128
April	108.9	91.4	16.2	103.8	104.2	159	5,131
May	108.9	91.4	126.2	101.9	104.4	155	5,131
June	108.9	91.4	126.2	100.3	104.7	153	5,131
July	108.9	83.8	126.2	98.3	104.8	150	5,131
August	108.9	83.8	102.5	96.1	104.8	146	5,141
September	108.9	83.8	102.5	100.8	105.0	154	5,141
October	108.9	88.0	102.5	102.0	105.2	155	5,141
November	108.9	88.0	102.5	101.4	105.1	154	5,141
December	108.9	88.0	102.5	99.8	105.1	150	5,131
1984							
January	108.9	88.0	101.8	98.7	105.1	149	5,131
February	108.9	85.4	101.8	97.8	105.1	148	5,131
March	n.a.	n.a.	n.a.	n.a.	n.a.	150	5,131

*Grade C heavy fuel oil. **Yen per liter. ***Yen per 10 cubic meters.

Sources: Bank of Japan and Prime Minister's Office

Table 4: Japan's Non-Crude Energy Imports

(in thousands of units)

	Coal (mt)	Naphtha (kl)	Fuel Oil (kl)	LPG (mt)	LNG (mt)
1979	58,214	10,365	9,491	9,491	13,926
1980	68,570	7,363	7,431	9,725	16,324
1981	77,959	7,241	7,404	10,097	16,833
1982	78,535	8,998	6,893	11,861	17,480
1983	75,124	13,096	7,276	10,857	18,748
January	6,133	1,074	485	907	1,601
February	4,866	773	529	983	1,367
March	5,955	916	681	995	1,611
April	5,923	941	491	800	1,147
May	6,307	1,177	395	985	1,332
June	6,221	1,158	489	975	1,264
July	6,172	933	527	903	1,553
August	7,133	1,219	647	685	1,649
September	6,348	1,197	1,014	735	1,708
October	6,542	1,167	667	859	1,659
November	6,783	1,175	749	1,032	1,885
December	6,741	1,366	602	997	1,971
1984					
January	6,551	1,347	565	1,066	2,181
February	6,558	1,390	600	773	1,954

Source: Ministry of International Trade and Industry

Table 5: Energy Consumption by Industry by Type

	Total oil equiv. (kl)	Fuels (kl)	Electricity (1,000 kwh)	Steam (mt)	Gasoline (kl)	Light Oil (kl)	Fuel Oil (kl)	LPG (mt)	Coal (mt)	Propane (1,000 cu m)
5a. Metal Mining										
1983	85,704	34,450	521,578	2,468	66	4,408	21,176	24	2,881	0
1st Qtr	22,906	9,961	134,324	842	11	882	6,820	6	279	0
2nd Qtr	18,658	6,329	123,158	541	20	903	3,490	6	712	0
3rd Qtr	20,235	7,433	128,826	412	17	959	3,967	6	896	0
4th Qtr	23,905	10,727	135,270	673	18	1032	6,899	6	994	0
1984										
1st Qtr	20,593	8,076	131,243	670	20	1017	4,335	11	871	0
5b. Coal Mining										
1983	663,943	592,695	719,746	0	12	11,270	4,330	0	586,524	0
1st Qtr	158,457	135,970	207,052	0	3	2,551	1,904	0	125,598	0
2nd Qtr	148,778	130,730	185,087	0	3	2,468	913	0	127,183	0
3rd Qtr	158,848	145,532	171,694	0	3	3,116	1,088	0	142,790	0
4th Qtr	197,860	180,463	155,913	0	3	3,135	425	0	190,953	0
1984										
1st Qtr	184,713	171,818	135,434	0	3	3,685	634	0	178,921	0
5c. Textiles										
1983	4,023,117	3,597,195	5,143,101	344,150	412	1,591	2,993,544	90,923	209,494	36,656
1st Qtr	1,047,271	928,678	1,155,105	118,900	103	383	786,915	21,980	47,144	7,429
2nd Qtr	908,597	865,374	1,322,380	83,139	101	383	724,768	22,044	44,327	10,109
3rd Qtr	1,021,717	885,257	1,347,885	70,731	105	380	743,773	22,262	47,190	9,302
4th Qtr	1,045,532	917,886	1,317,731	71,380	103	445	738,088	24,637	70,833	9,816
1984										
1st Qtr	1,107,109	983,639	1,245,361	77,072	96	420	798,139	26,034	68,462	10,099
5d. Pulp, Paper and Cardboard										
1983	10,480,791	9,337,339	11,570,067	590,881	477	1,808	4,705,871	39,491	971,472	15,358
1st Qtr	2,702,898	2,434,898	2,716,460	155,514	122	449	1,268,892	10,357	264,051	3,850
2nd Qtr	2,552,336	2,256,789	2,984,266	152,280	119	455	1,119,246	8,904	233,581	5,536
3rd Qtr	2,535,243	2,244,598	2,921,922	138,382	114	423	1,098,027	9,245	221,503	2,970
4th Qtr	2,690,314	2,401,054	2,947,419	144,705	122	481	1,219,706	10,985	252,337	3,002
1984										
1st Qtr	2,774,319	2,501,497	2,742,982	213,908	114	507	1,282,060	11,266	272,822	4,753
5e. Chemicals										
1983	57,216,628	53,663,496	35,000,370	25,001,640	641	148,347	5,919,405	2,499,865	13,736,636	39,381
1st Qtr	14,318,711	13,088,243	6,762,101	5,658,974	164	16,418	1,541,886	678,369	3,244,622	9,902
2nd Qtr	13,653,886	12,595,987	9,154,360	5,153,172	156	60,198	1,425,456	501,075	3,451,977	9,404
3rd Qtr	14,876,064	13,611,299	9,341,328	5,377,255	154	37,934	1,489,988	632,404	3,533,950	8,725
4th Qtr	14,367,967	14,367,967	9,742,581	5,812,239	167	33,797	1,462,075	688,017	3,506,087	11,350
1984										
1st Qtr	16,196,226	14,891,257	9,525,653	6,207,630	158	48,622	1,613,605	731,095	3,531,067	8,914
5f. Petrochemicals										
1983	10,671,359	10,252,467	2,862,854	2,309,131	622	2,715	3,659,233	170,909	0	43
1st Qtr	2,915,229	2,809,829	681,265	633,604	159	496	1,114,860	33,908	0	12
2nd Qtr	2,453,448	2,353,574	668,978	568,849	151	603	878,077	35,565	0	10
3rd Qtr	2,500,956	2,395,241	763,243	527,906	164	958	764,183	45,538	0	10
4th Qtr	2,801,726	2,693,823	749,368	578,772	148	658	902,113	55,898	0	11
1984										
1st Qtr	2,973,144	2,861,401	727,849	664,235	155	651	975,865	48,604	0	16

Table 5 - continued

	Total oil equiv. (kl)	Fuels (kl)	Electricity (1,000 kwh)	Steam (mt)	Gasoline (kl)	Light Oil (kl)	Fuel Oil (kl)	LPG (mt)	Coal (mt)	Propane (1,000 cu m)
5g. Rubber Products										
1983	421,307	511,718	1,372,386	442	563	126	256,992	9,883	0	8,140
1st Qtr	109,581	80,785	314,761	0	108	25	70,647	2,537	0	2,009
2nd Qtr	99,951	285,080	337,420	0	148	37	59,948	2,287	0	2,005
3rd Qtr	100,049	66,835	362,702	442	149	29	57,925	2,304	0	1,985
4th Qtr	111,726	79,018	357,503	0	158	35	68,472	2,755	0	2,141
1984										
1st Qtr	120,508	88,465	350,240	0	167	32	77,142	2715	0	2113
5h. Ceramics, Mineral and Glass Products										
1983	15,482,503	13,704,248	17,650,915	889,485	1,554	28,424	3,007,179	192,953	8,841,061	74,080
1st Qtr	3,851,741	3,406,708	4,298,155	252,677	411	6,956	723,746	51,673	2,130,041	16,177
2nd Qtr	3,766,424	3,330,893	4,005,142	183,705	394	6,816	737,637	47,181	2,114,575	16,991
3rd Qtr	3,839,295	3,411,167	3,923,939	214,477	371	7,164	777,798	45,824	2,194,552	18,749
4th Qtr	4,025,043	3,555,480	5,423,679	238,626	378	7,488	767,998	48,275	2,401,893	22,163
1984										
1st Qtr	3,633,007	3,191,379	4,355,255	274,389	346	6,729	782,611	50,174	2,159,973	21,493
5i. Iron and Steel										
1983	45,462,302	40,204,863	53,038,384	3,822,903	6,307	66,621	2,194,392	412,776	25,005,508	98,590
1st Qtr	10,996,218	9,706,519	13,144,789	906,218	1,487	17,822	570,391	111,274	6,010,547	25,315
2nd Qtr	11,152,201	9,831,906	13,307,969	800,322	1,702	17,106	527,998	99,817	6,052,492	20,007
3rd Qtr	11,424,961	10,152,018	12,807,441	905,873	1,586	15,211	535,090	99,128	6,377,992	25,688
4th Qtr	11,888,922	10,514,420	13,778,185	1,210,490	1,532	16,482	560,913	102,557	6,564,477	27,580
1984										
1st Qtr	12,083,344	10,723,888	14,745,412	1,285,683	1597	16,867	619,319	108,464	6,684,202	28,028
5j. Non-Ferrous Metal Ores and Manufactures										
1983	4,375,242	2,880,660	14,609,000	1,054,817	1,074	6,320	1,216,257	184,255	870,492	41,726
1st Qtr	1,113,383	760,031	3,543,701	678,471	263	1,550	342,282	48,636	209,217	9,574
2nd Qtr	1,027,525	652,356	3,630,200	124,201	267	1,554	261,844	44,285	201,124	9,803
3rd Qtr	1,077,577	703,368	3,607,840	116,371	271	1,547	291,102	43,557	228,108	10,882
4th Qtr	1,156,757	764,905	3,827,259	135,774	273	1,669	321,029	47,777	232,043	11,467
1984										
1st Qtr	1,155,894	763,064	3,974,317	152,413	295	1,741	320,570	48,905	231,702	12,117
5k. Machinery										
1983	13,676,921	10,778,350	31,682,053	0	103,466	66,043	1,456,965	347,114	889	377,619
1st Qtr	3,542,895	2,861,352	7,449,429	0	26,108	16,816	523,683	93,638	320	97,213
2nd Qtr	3,211,280	2,506,830	7,699,800	0	26,331	16,501	277,011	84,689	160	88,655
3rd Qtr	3,316,994	2,552,765	8,353,194	0	25,065	15,746	264,099	79,078	154	86,699
4th Qtr	3,605,752	2,857,403	8,179,630	0	25,962	16,980	392,172	89,709	255	105,052
1984										
1st Qtr	3,977,599	3,224,280	8,233,956	0	26,054	17,653	620,409	97,839	230	114,347

Source: Ministry of International Trade and Industry

Table 6: Japan's Electric Utility Output

(in billions of kilowatt hours)

	Total	Hydro	Thermal	Nuclear
1979	521.62	78.58	373.70	69.34
1980	514.05	85.15	346.90	82.01
1981	523.14	83.74	352.18	87.23
1982	522.48	77.34	343.30	101.84
1983	542.12	85.75	348.54	107.86
January	44.26	5.26	30.99	8.01
February	42.34	4.30	31.31	6.74
March	45.26	6.75	30.72	7.78
April	40.93	9.51	23.14	8.28
May	41.51	9.69	22.71	9.11
June	43.11	7.27	26.87	8.97
July	48.74	9.25	29.98	9.52
August	52.51	9.04	32.92	10.56
September	47.19	7.30	29.80	10.09
October	44.11	7.33	26.51	10.28
November	44.09	4.85	30.32	8.92
December	48.07	5.20	33.27	9.60
1984				
January	47.89	4.38	33.65	9.85

Source: Ministry of International Trade and Industry.

Table 7: Household Energy Consumption

	Electricity (mil kwh)	Propane (bil kcal)	Kerosene (1,000 kl)	LPG (1,000 mt)	Other Solids (1,000 mt)	Coal (1,000 mt)
1979	103,135	52,673	17,515	5,531	1,041.4	537.1
1980	103,199	56,007	16,725	4,984	1,212.3	578.5
1981	108,979	58,178	16,730	5,336	970.0	472.5
1982	110,051	58,201	15,275	5,295	1,173.1	512.8
1983	117,905	60,746	15,928	5,460	1,010.3*	509.2
January	11,212	7,131	2,248	533	73.2	43.2
February	10,250	6,942	2,246	474	76.9	46.0
March	9,511	6,706	2,083	528	91.8	46.1
April	9,986	6,251	907	497	70.0	25.4
May	8,794	5,015	607	426	81.6	22.4
June	8,090	3,848	524	398	91.4	35.9
July	8,971	3,739	510	373	88.6	39.4
August	10,913	3,373	552	363	88.5	46.5
September	11,719	3,086	641	332	91.3	63.1
October	9,501	3,637	920	393	96.2	49.3
November	9,021	4,816	1,645	498	68.1*	44.5
December	9,937	6,200	3,045	642	92.7*	47.4
1984						
January	12,071	8,087	n.a.	n.a.	78.0*	34.9

* Partial data only.

Source: Ministry of International Trade and Industry

Table 8: Long-Term Outlook for Energy Supply and Demand

Source	Units	FY 1982		FY 1990		FY 1995		FY 2000	
		Volume	Share	Volume	Share	Volume	Share	Volume	Share
Coal	mil. mt	94.5	18.5%	108.0	18%	128.0	18%	160-170.0	20%
Nuclear	gigawatts	17.3	6.9	34.0	11	48.0	14	62.0	16
Natural Gas	mil. kl	27.0	7.0	56.0	12	61.0	12	64-66.0	11
Hydroelectric	gigawatts	33.3	5.4	40.0	5	43.5	5	48.5	5
Geothermal	mil. kl	0.4	0.1	1.5	0.3	3.5	1	6-7.0	1
New sources	mil. kl	0.9	0.2	8.0	2	19.0	4	35-55.0	6-9
Oil	mil. kl	240.0	61.9	240.0	53	250.0	48	250-260.0	42
Total Supply	mil. kl	388.0	100.0	460.0	100.0	530	100.0	600.0	100.0

Quantity and Share of Energy Demand by Sector

(in millions of kiloliters)

	FY 1982		FY 1990		FY 1995		Average Annual Growth Rate
	Volume	Share	Volume	Share	Volume	Share	
Total Demand	375	100%	443	100%	500	100%	2.2%
Industry	218	58	240	54	261	52	1.4
Transportation	64	17	78	18	88	18	2.5
Household-Service	94	25	125	28	151	30	3.7

Source: Ministry of International Trade and Industry

Table 9: Outlays of the New Energy Development Oranization (NEDO)

(in billions of yen)

	FY 1982	FY 1983
New Energy Related Projects	Y105.8	Y100.4
Petroleum Substitution Technology	34.3	38.4
Coal energy	18.0	20.5
Solar energy	7.3	7.8
Geothermal energy	6.1	5.7
Other alternative energies	2.9	4.4
Coal Resource Development	61.3	52.3
Overseas prospecting loans	10.6	7.5
Oversease devlopment debt guarantees	48.1	42.1
Basic survey of coal resources	1.8	1.9
Other	0.8	0.8
Geothermal Resource Development	9.3	8.8
National survey of geothermal resources	2.5	1.9
Advanced research on geothermal power	3.1	3.2
Geothermal development debt guarantees	3.7	3.7
Development Related Expenditures	0.9	0.9
Coal Rationalization Program	75.3	91.3
Support for Domestic Coal Industry	73.9	90.1
Renovation of Coal Mines	1.4	0.9
Other	0.3	0.3
Alcohol Production Programs	7.6	17.9
Total	188.7	209.6